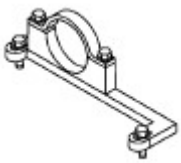
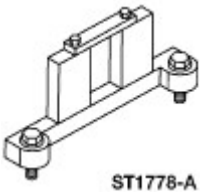
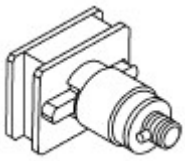
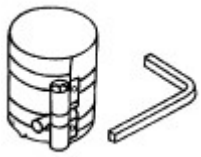
Engine

Special Tool(s)

 ST1774-A	Timing Chain Tensioner 303-571 (T97T-6K254-A)
 ST1777-A	Camshaft Gear Holding Tool 303-564 (T97T-6256-B)
 ST1776-A	Camshaft Gear Holding Tool Adapter 303-578 (T97T-6256-A)
 ST1778-A	Camshaft Holding Tool 303-577 (T97T-6256-C)
 ST1779-A	Camshaft Holding Tool Adapter 303-576 (T97T-6256-D)
 ST1287-A	Crankshaft Damper Replacer 303-102 (T74P-6316-B)
 ST1775-A	Crankshaft Holding Tool 303-573 (T97T-6303-A)

	Piston Ring Compressor 303-D032 (D81L-6002-C)
	Valve Spring Compressor 303–581 (T97T-6565-A)
	Rear Jackshaft Socket 303-634

Material

Item	Specification
Metal Surface Cleaner F4AZ-19A536-RA	WSE-M5B392-A
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP	WSS-M2C153-H
Silicone Gasket and Sealant F7AZ-19554-EA	WSE-M4G323-A4
Motorcraft Silicone Brake Caliper Grease and Dielectric Compound XG-3	ESE-M1C171-A

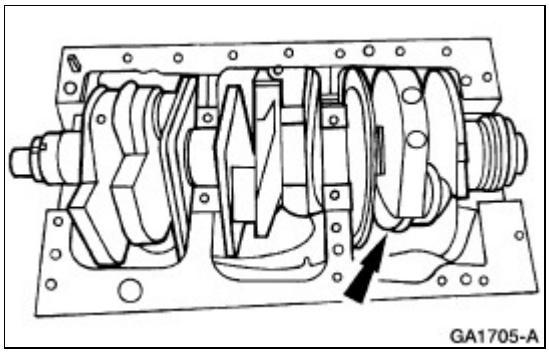
CAUTION: This vehicle is equipped with a composite material fuel supply manifold. If the supply manifold is used as a leverage device, damage may occur to the supply manifold. Care must be taken when working around the fuel supply manifold.

NOTE: Before engine assembly, use metal surface cleaner and a suitable plastic or wooden scraper to clean the sealing surfaces. All sealing surfaces must be clean. Make sure coolant and oil passages are clear.

1. Install the crankshaft main bearings and the thrust bearing.
   - Lubricate the crankshaft main bearings with clean engine oil.

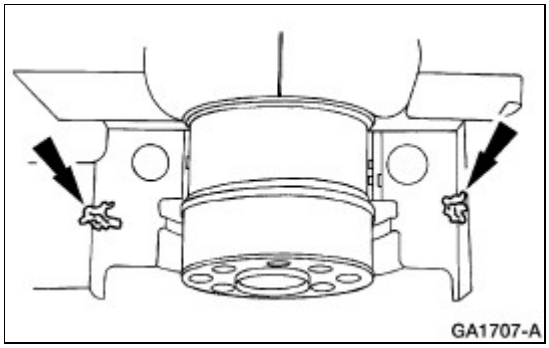
2. **NOTE:** The crankshaft main bearings are precision selective fit. Inspect the bearing clearance. For additional information, refer to Section 303-00 .

   Install the crankshaft.

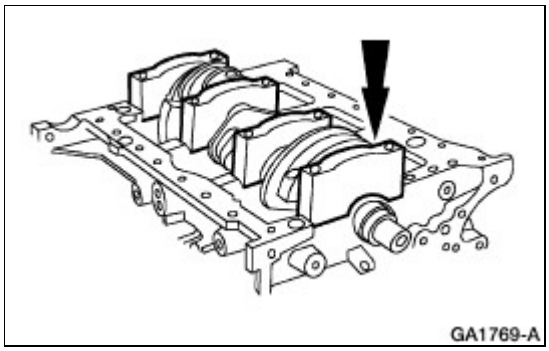


3. **NOTE:** The rear main bearing cap must be installed within four minutes after applying the silicone.

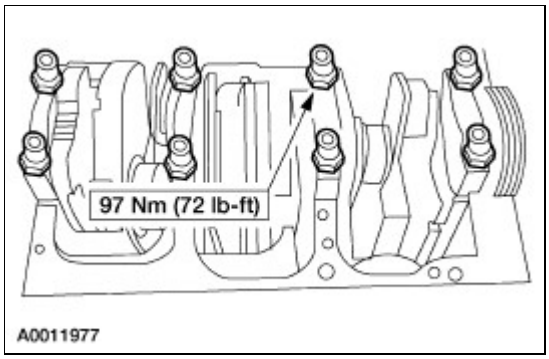
   Apply silicone gasket and sealant to the rear main bearing cap to cylinder block parting line.



4. Install the crankshaft main bearings in the main bearing caps.
5. Install the main bearing caps.



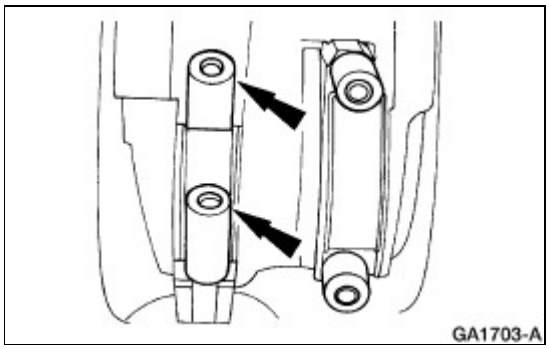
6. Tighten the bolts.



7. Lubricate the piston rings with clean engine oil.

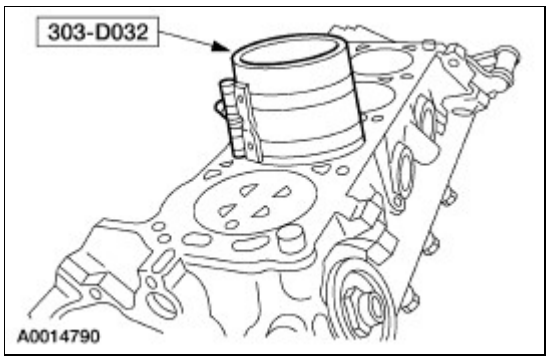
8. Make sure that the piston rings are correctly spaced. For additional information, refer to Section 303-00 .

9. Install rubber hose pieces on the connecting rod bolts to protect the crankshaft.



10. **NOTE:** Position the piston with the indentation arrow toward the front of the cylinder block.

    Using the special tool, install the pistons.



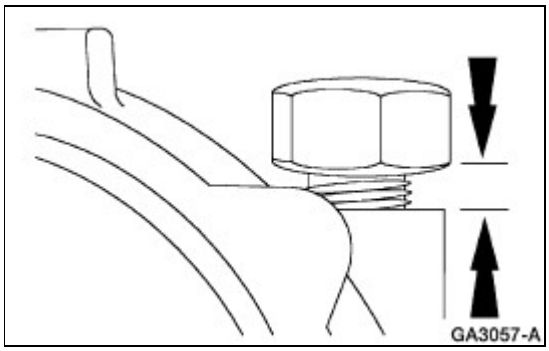
11. **NOTE:** The old nuts and bolts are used for checking clearances. New nuts and bolts must be used for reassembly.

    Check the clearance of each connecting rod bearing. For additional information, refer to Section 303-00 .

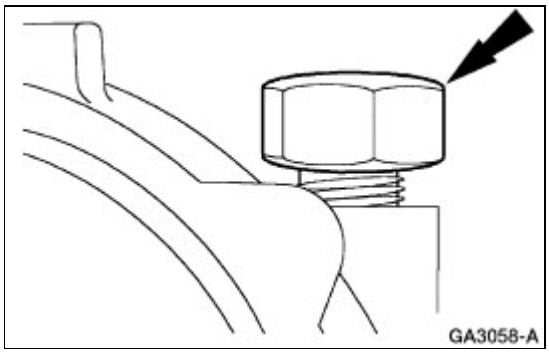
12. Rotate the crankshaft until the piston is at the bottom of its stroke.

13. **NOTE:** For cylinders 1, 2, and 3, remove the connecting rod nut at the oil split hole side first. For cylinders 4, 5, and 6, remove the opposite nut first.

    Loosen the first nut until the face is approximately 2 mm (0.08 in) over the end of the bolt.

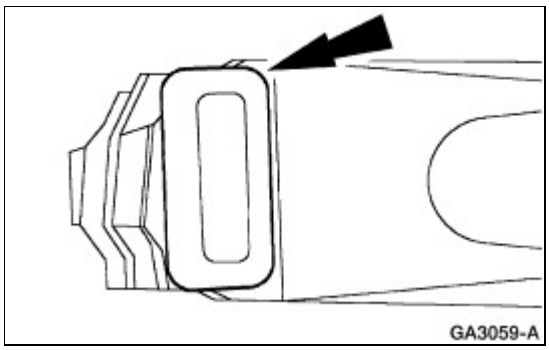


14. Tap the bolt on the nut until it can be removed by hand.



15. Repeat previous two steps for the opposite bolt.

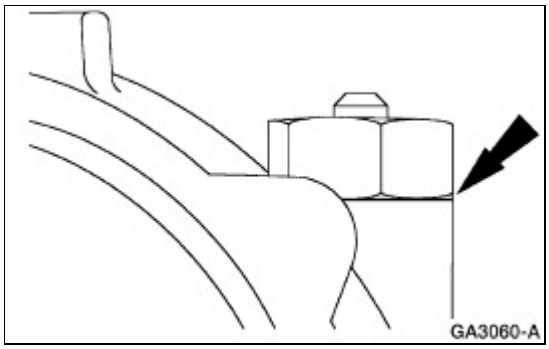
16. Install the new bolts making certain that the bolt head is parallel to the sideward face of the connecting rod.



17. Install the connecting rod cap in the original position.

18. **NOTE:** Do not exceed 20 Nm (15 lb-ft) when tightening the connecting rod nuts.

    Install and tighten the connecting rod nuts until they touch the connecting surface of the connecting rod cap.

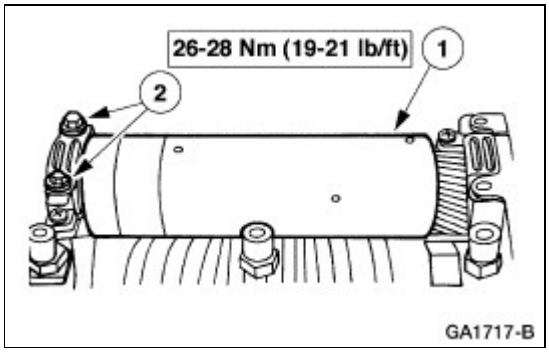


19. Tighten the connecting rod nuts simultaneously in two stages:
    - Stage 1: Tighten 20 Nm (15 lb-ft) .
    - Stage 2: Tighten 90 degrees.

20. Repeat previous four steps for the remaining connecting rods.

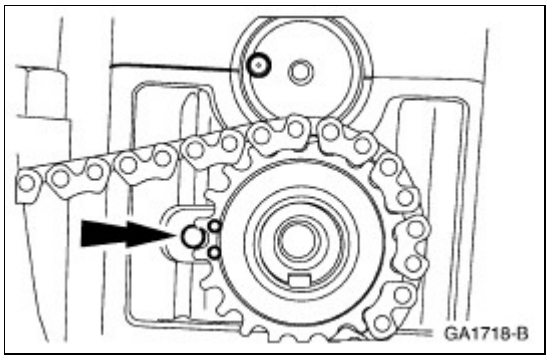
21. Rotate crankshaft until No.1 piston is at top dead center.

22. On 4 x 4 vehicles, install the balance shaft.
    1. Install the balance shaft assembly.
    2. Install the bolts.

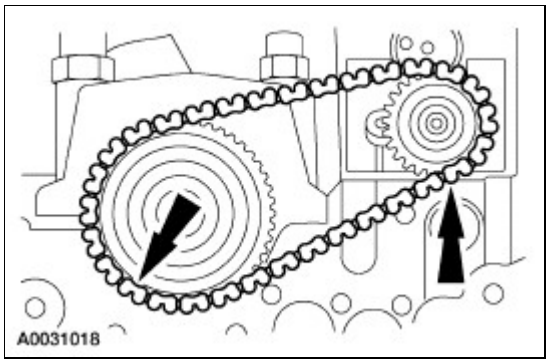


23. **NOTE:** Due to the gear ratio between the reversal shaft and the balance shaft, up to seven complete turns of the balance shaft may be required to find the correct position.

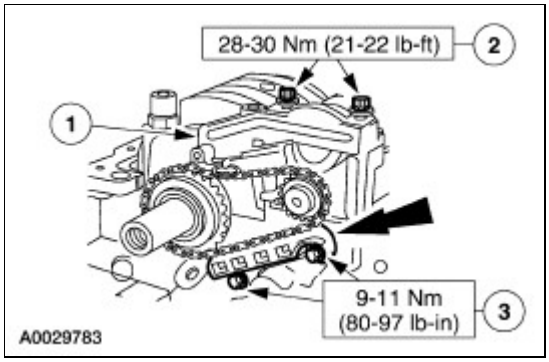
    On 4 x 4 vehicles, align the timing marks.
    - Install a 4 mm pin to hold the shaft in place.



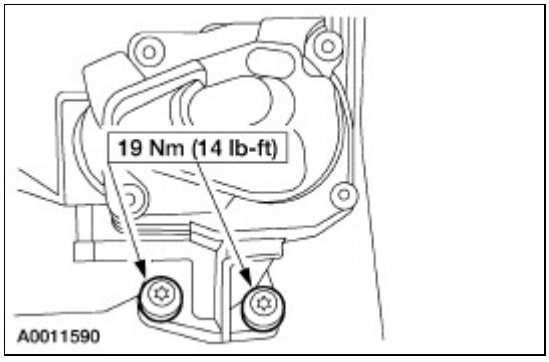
24. On 4 x 4 vehicles, install the balance shaft chain and crankshaft sprocket.



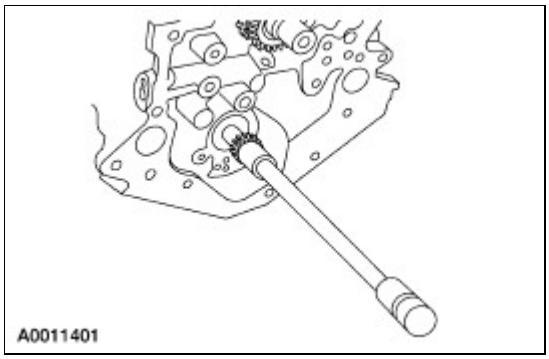
25. On 4 x 4 vehicles, install the balance shaft tensioner.
    1. Install the balance shaft tensioner.
    2. Install the bolts.
    3. Position the balance shaft chain guide and install the two bolts.
    - Remove the pin from the tensioner.



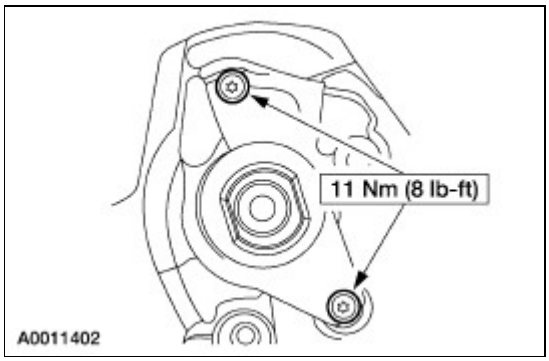
26. Install the oil pump.



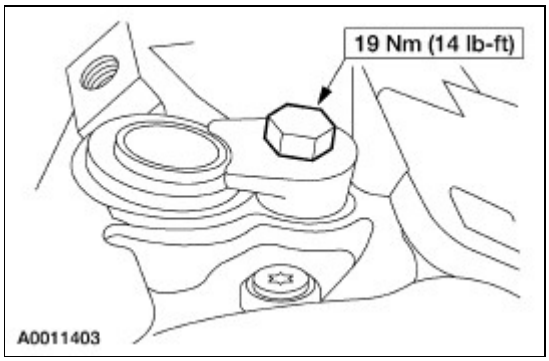
27. Install the jackshaft.



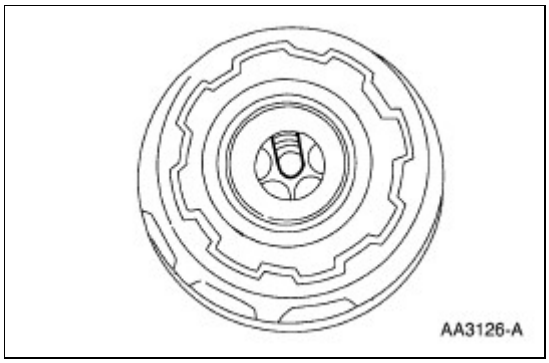
28. Install the jackshaft thrust plate and bolts.



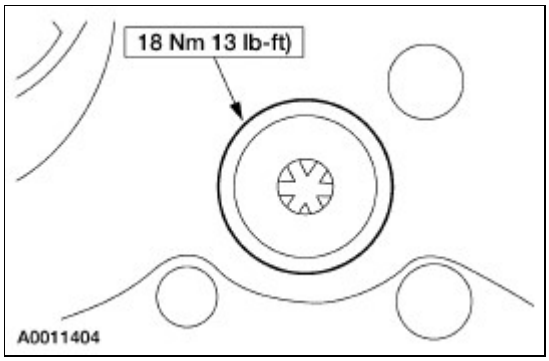
29. Install the oil pump drive.



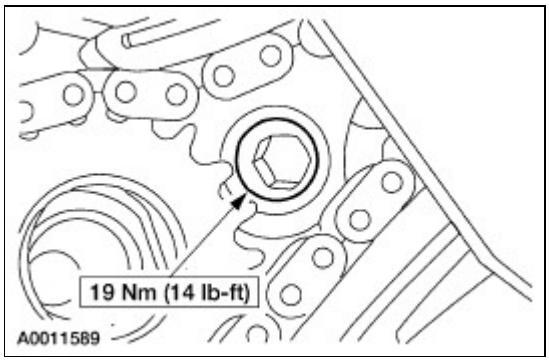
30. Attach the rear cassette and sprocket to the bolt. Do not tighten at this time.



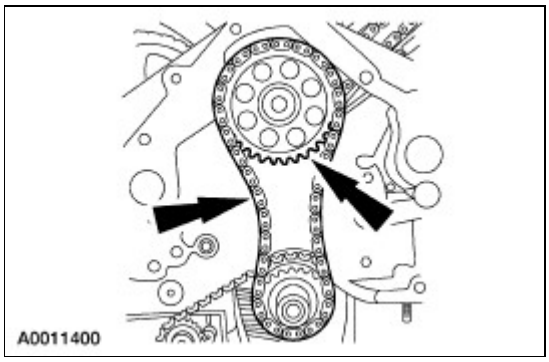
31. Install the rear cassette and bolt.



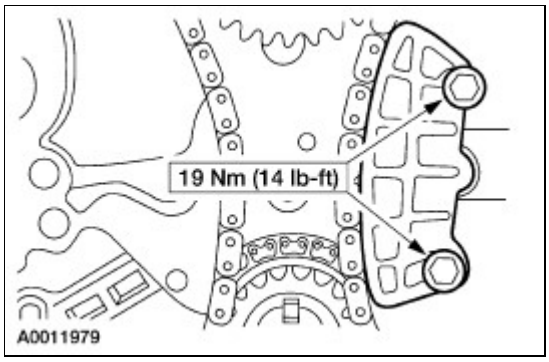
32. Install the front cassette and bolt.



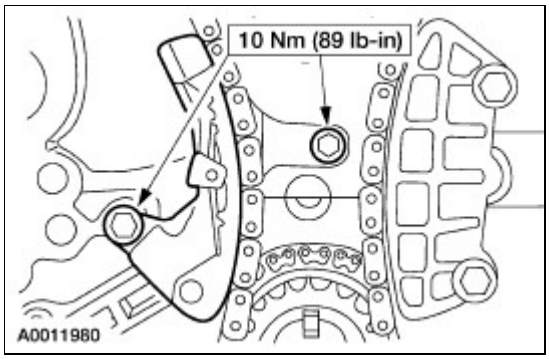
33. Position the jackshaft sprocket and chain.



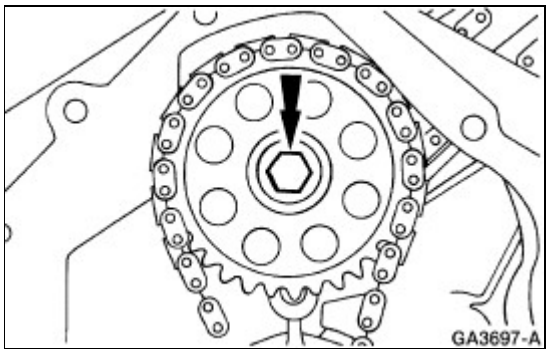
34. Install the chain guide.



35. Install the chain tensioner.

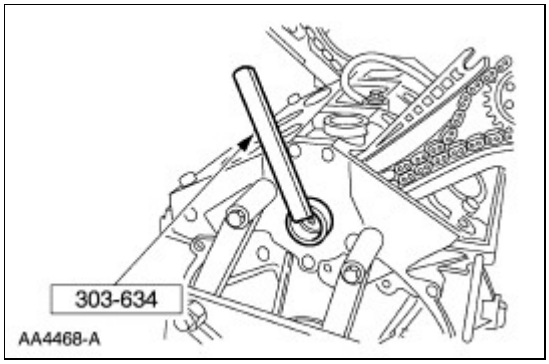


36. Install the bolt. Do not tighten at this time.

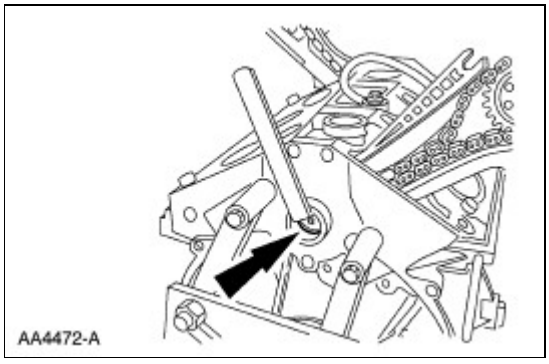


37. While holding the front jackshaft sprocket bolt secure, tighten the rear bolt to 20 Nm (15 lb-ft).

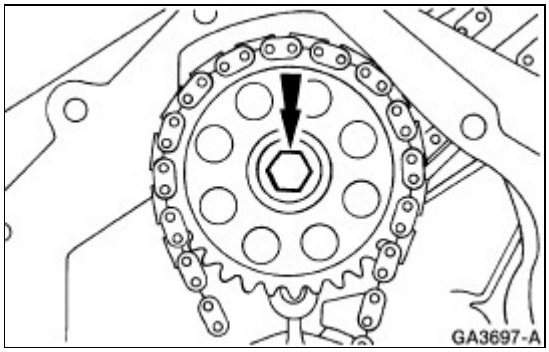
38. Install the special tool on the rear of the jackshaft.



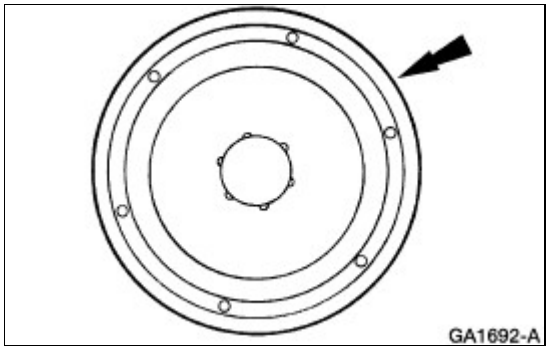
39. Tighten the rear bolt an additional 90 degrees.



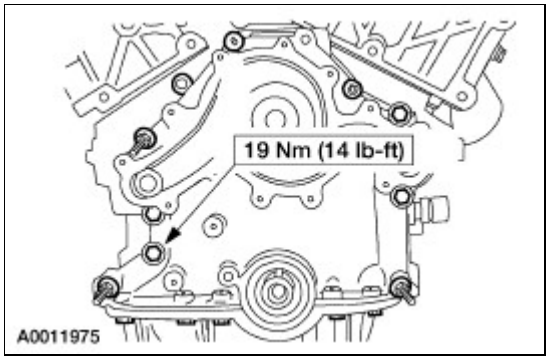
40. Tighten the front bolt in two stages.
    - Stage 1: Tighten to 45 Nm (33 lb-ft).
    - Stage 2: Tighten 90 degrees.



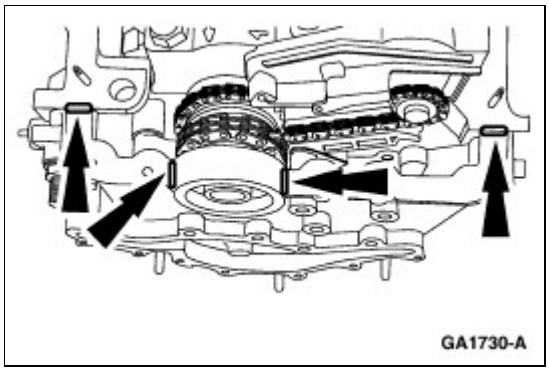
41. Remove the special tool and install the rear jackshaft plug.



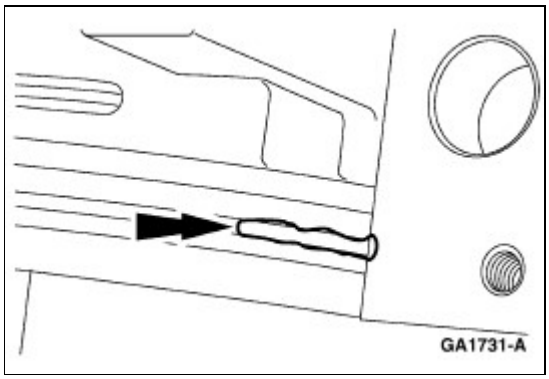
42. Position the front cover gasket and install the front cover.



43. Apply silicone gasket and sealant to the front cover in four places.

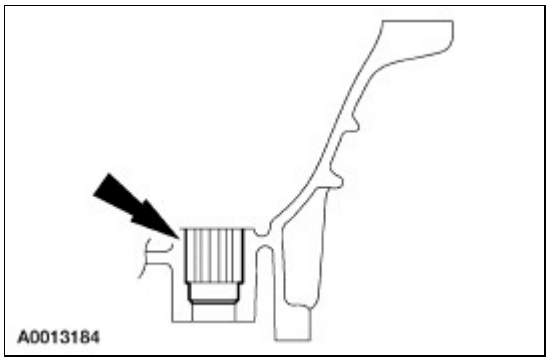


44. Apply silicone gasket and sealant to the rear main bearing cap as shown.
    - Position the ladder frame gasket.

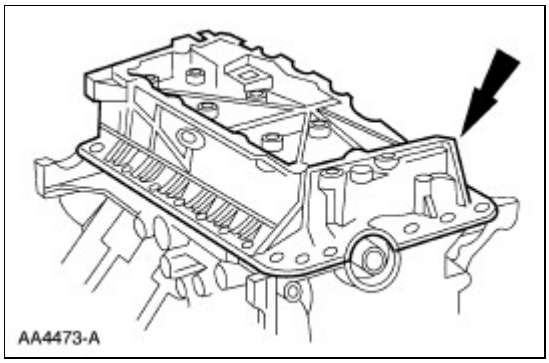


45. **CAUTION: The ladder frame inserts must be loosened completely or damage to the ladder frame and/or oil leaks may result.**

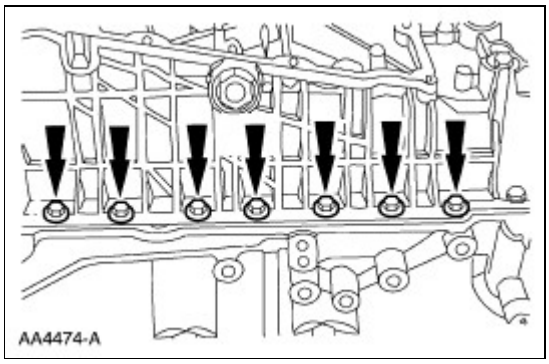
    Loosen the ladder frame inserts.



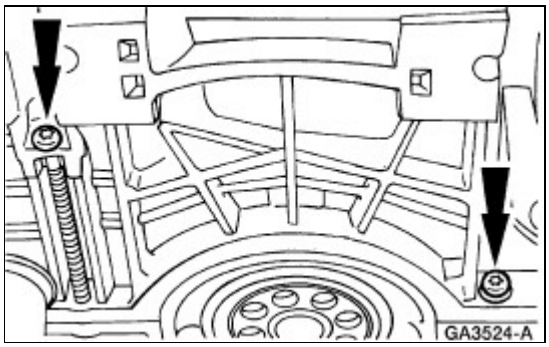
46. Position the ladder frame and gasket assembly.



47. Install and hand tighten the fifteen bolts and two nuts.

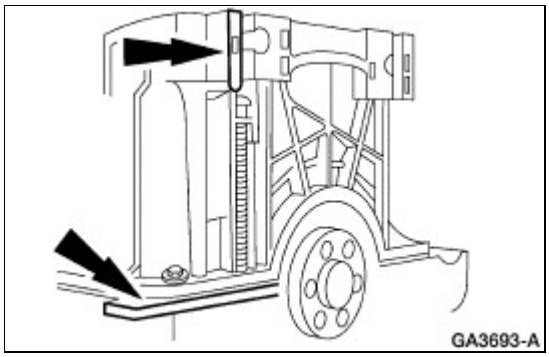


48. Install and hand tighten the bolts.

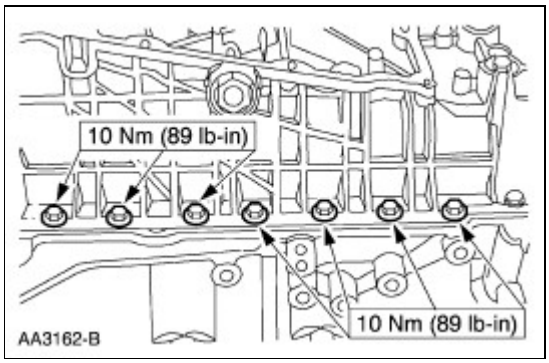


49. **NOTE:** The ladder frame to cylinder block alignment must be within a maximum mismatch of 0.25 mm (0.01 in) ladder frame underflush or 0.05 mm (0.00196 in) ladder frame protrusion.

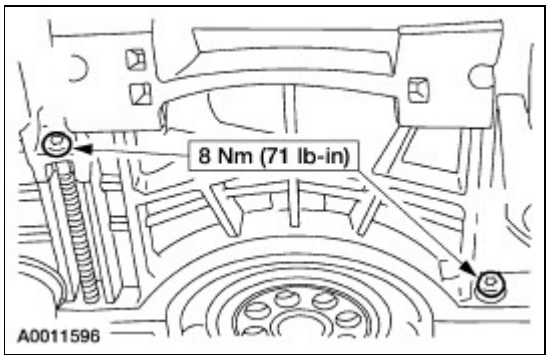
    Using a straightedge, align the transmission face of the ladder frame with the rear face of the cylinder block.



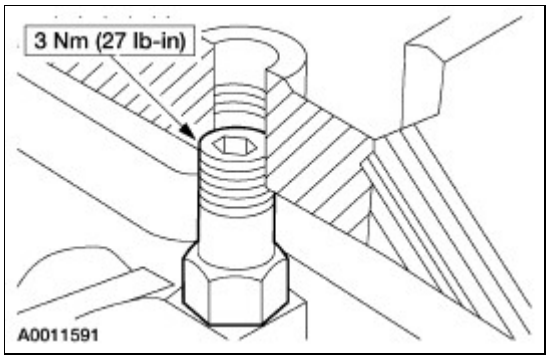
50. Tighten the fifteen bolts and two nuts.



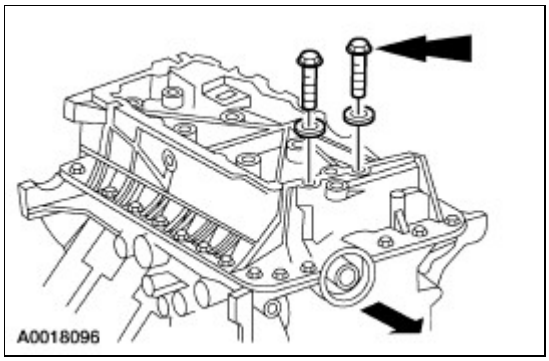
51. Tighten the bolts.



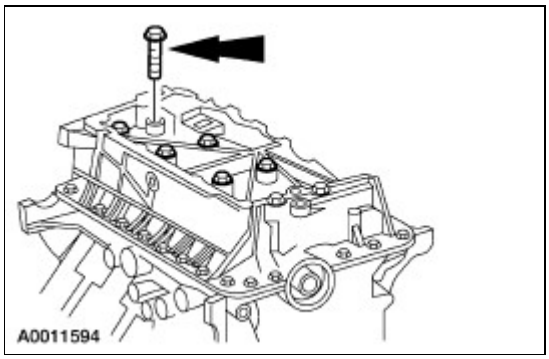
52. Tighten the inserts.



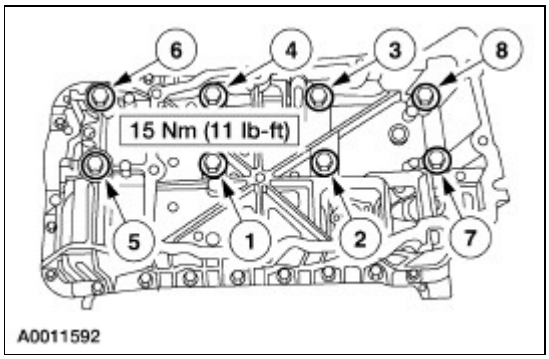
53. Install new seals on the two silver bolts and position them in the ladder frame.



54. Position the six remaining bolts.

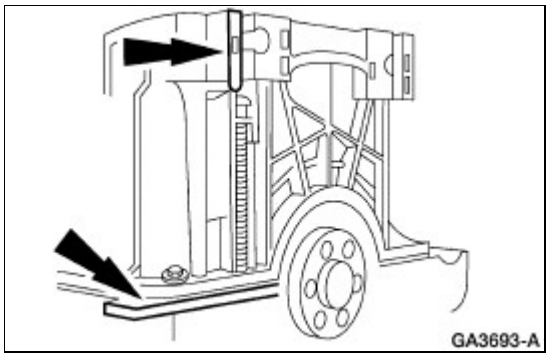


55. Tighten the ladder frame bolts in two stages.
    - Stage 1: Tighten to 15 Nm (11 lb-ft).
    - Stage 2: Tighten to 33 Nm (24 lb-ft).

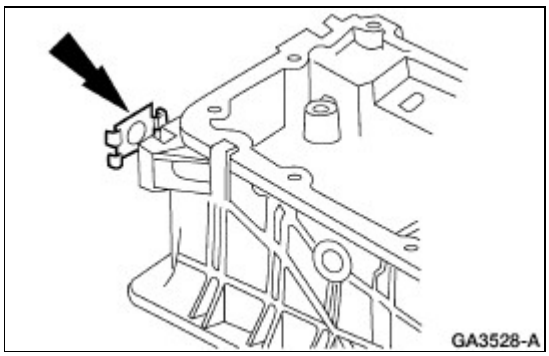


56. **NOTE:** Assemblies that measure out of specification must have the entire assembly procedure repeated.

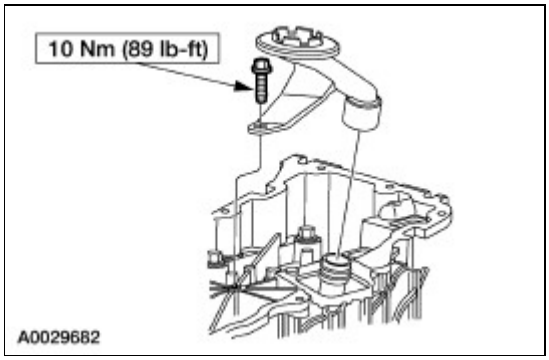
    Measure the step between the rear face of the cylinder block and the transmission face of the ladder frame.



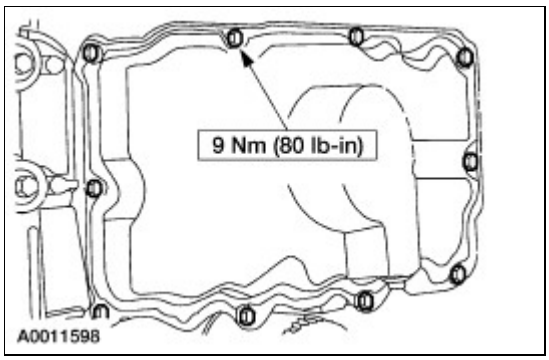
57. Repair all assemblies that exceed underflush specification by installing shims on one or both sides of the ladder frame.



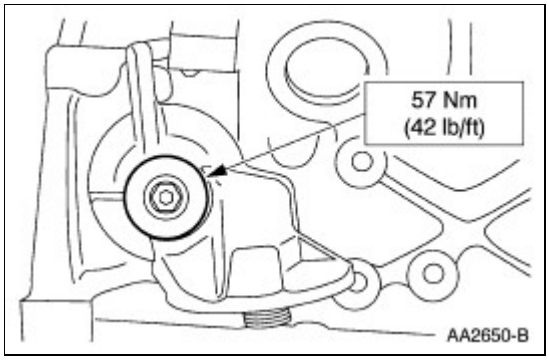
58. Install the oil pump screen and pickup tube.



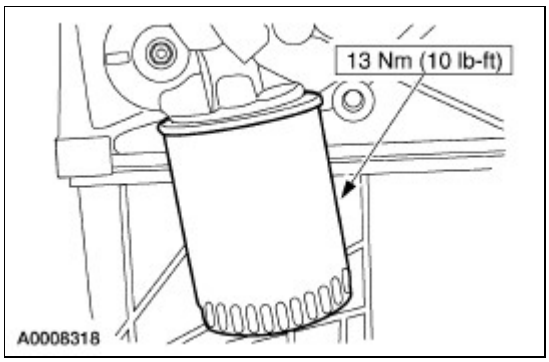
59. Install the gasket, and the oil pan.



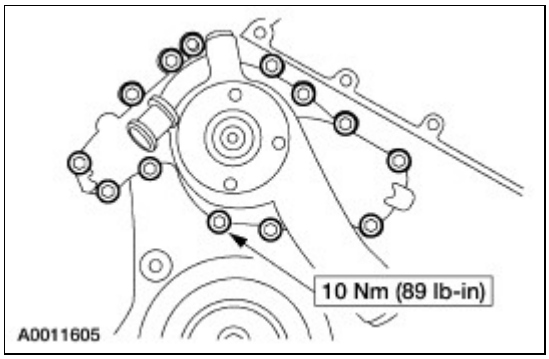
60. Install the oil filter adapter.



61. Install the oil filter.

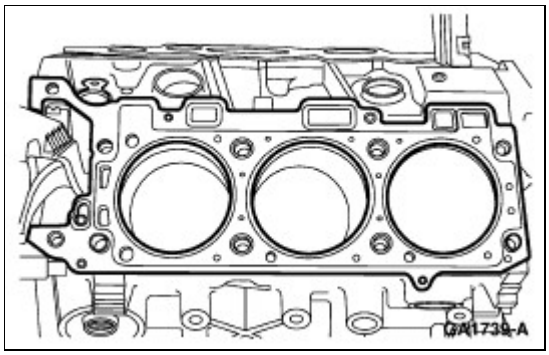


62. Install the water pump.



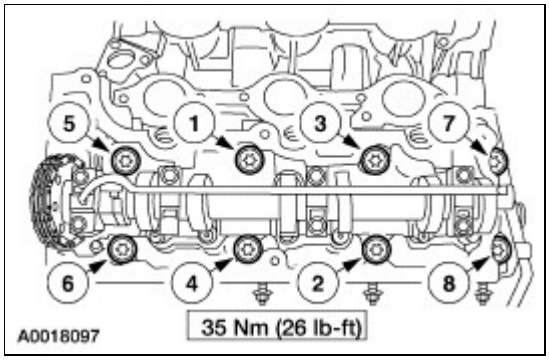
63. **NOTE:** LH shown, RH similar.

    Install the cylinder head gasket.



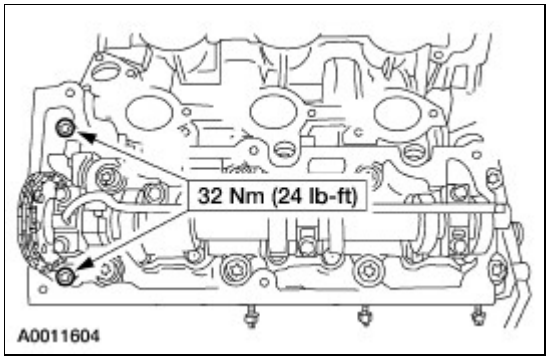
64. **NOTE:** LH shown, RH similar.

    Install the cylinder head and tighten the bolts in the sequence shown.



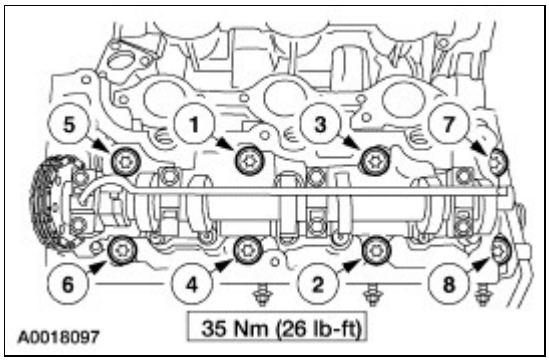
65. **NOTE:** LH shown, RH similar.

    Install the two 8 mm bolts.



66. **NOTE:** LH shown, RH similar.

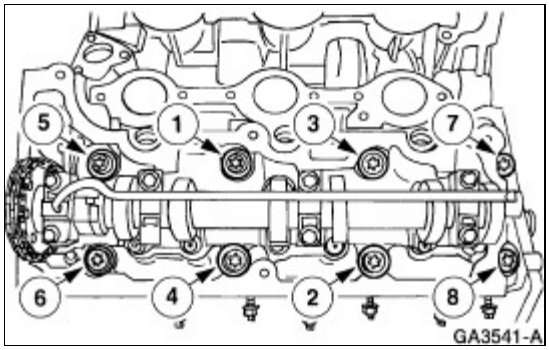
    Tighten the 12mm bolts in the sequence shown.



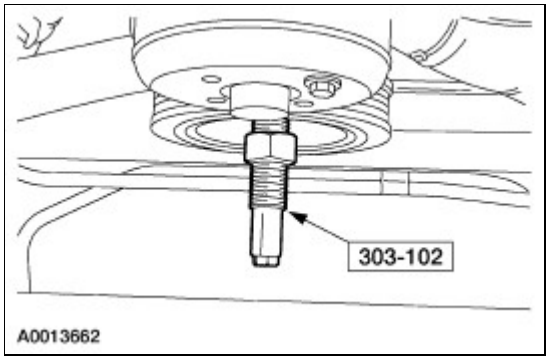
67. **NOTE:** LH shown, RH similar.

Tighten the bolts in the sequence shown in two stages.

- Stage 1: Rotate 90 degrees.
- Stage 2: Rotate an additional 90 degrees.



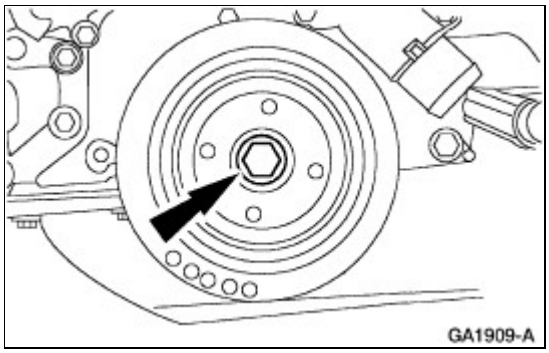
68. Using the special tool, install the crankshaft pulley.



69. **CAUTION: A new bolt must be used each time it is removed.**

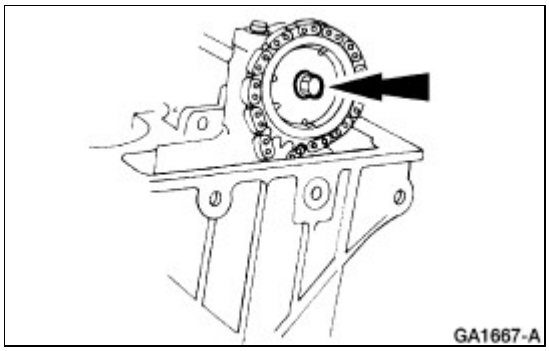
Tighten the bolt in two stages.

- Stage 1: Tighten to 45 Nm (33 lb-ft).
- Stage 2: Rotate an additional 90 degrees.

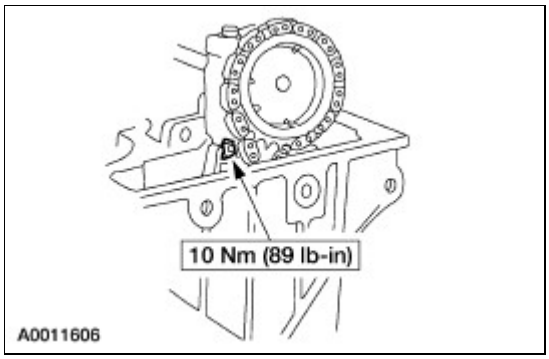


70. **CAUTION: The camshaft sprocket must turn freely on the camshaft. DO NOT tighten the bolt.**

    Install the RH rear camshaft bolt.

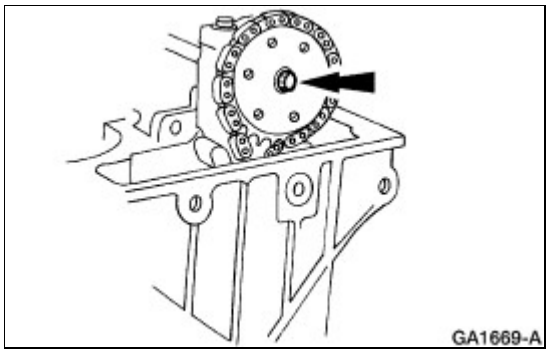


71. Install the bolt.

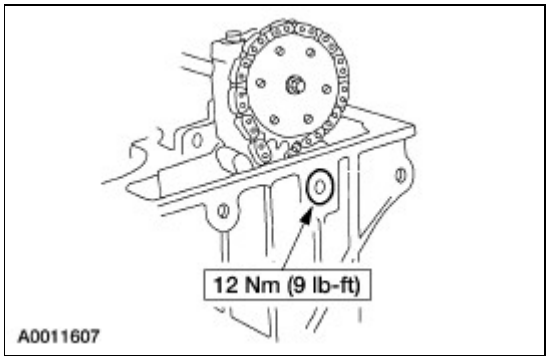


72. **CAUTION: The camshaft sprocket must turn freely on the camshaft. DO NOT tighten the bolt.**

    Install the LH front camshaft bolt.



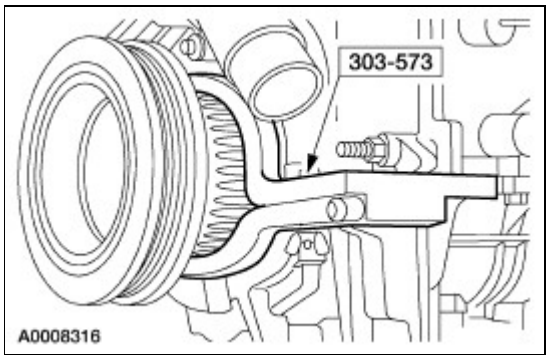
73. Install the bolt.



74. Turn the crankshaft one revolution clockwise.

75. **NOTE:** The special tool must be installed on the damper and should contact the engine block, this positions the engine at top dead center (TDC).

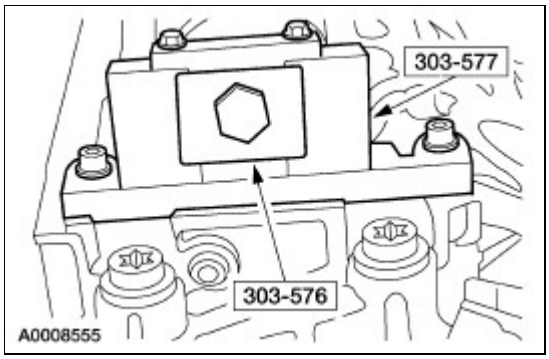
    Install the special tool.



76. **NOTE:** Camshaft timing slots are off-center.

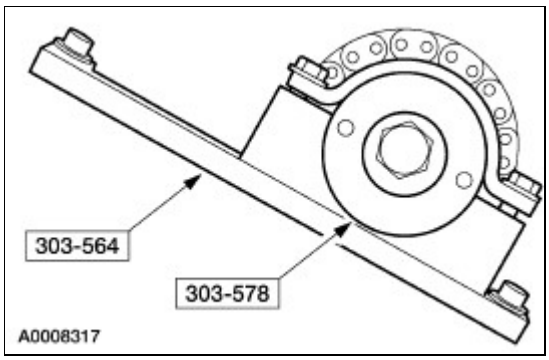
    NOTE: Position the camshaft timing slots below centerline of camshaft to correctly fit the special tools.

    Install the special tools on the front of the RH cylinder head.

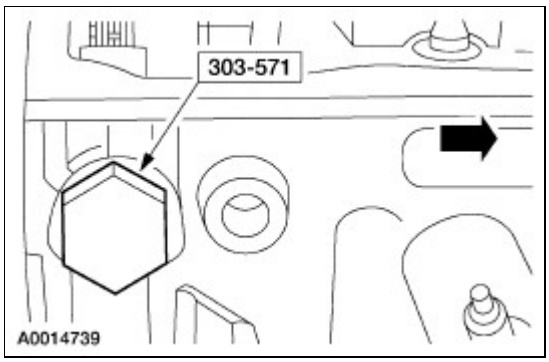


77. **NOTE:** Leave the top two special tool clamp bolts loose.

    Install the special tools on the rear of the RH cylinder head.

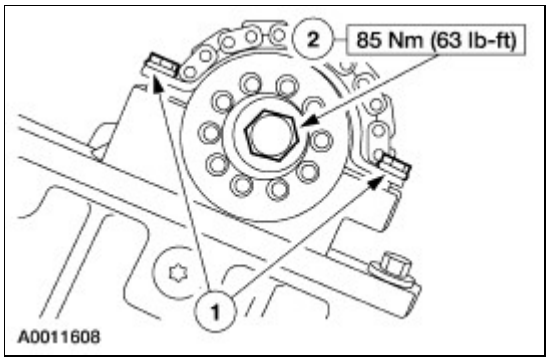


78. Install the special tool.



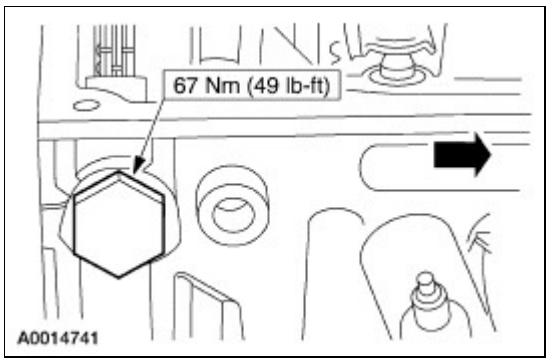
79. **CAUTION: The right-hand camshaft sprocket bolt is a left-hand threaded bolt.**

    Tighten the bolts.
    1. Tighten the special tool top two clamp bolts to 10 Nm (89 lb-in).
    2. Tighten the camshaft bolt.



80. **NOTE:** When using a new washer the camshaft tensioner must be torqued to 44Nm (32lb-ft).

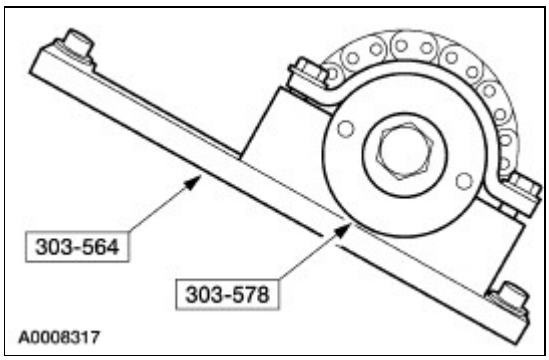
    Remove the special tool and install the RH camshaft tensioner.



81. Remove the special tools from the RH cylinder head.

82. **NOTE:** Do not tighten the special tool top two clamp bolts. Camshaft sprocket must rotate freely.

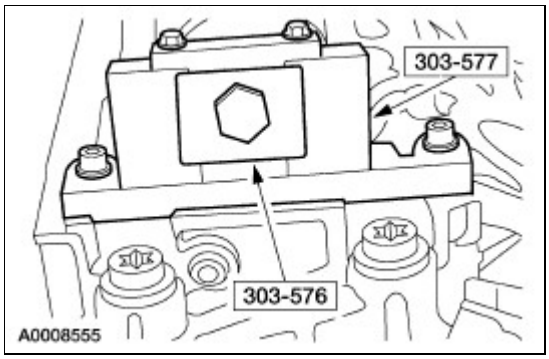
    Install the special tools on the front of the LH cylinder head.



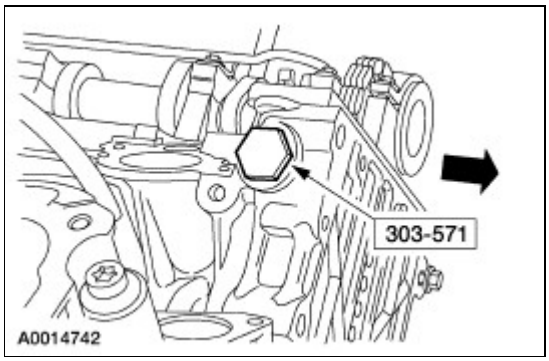
83. **NOTE:** Camshaft timing slots are off-center.

    NOTE: Position the camshaft timing slots below centerline of camshaft to correctly fit the special tools.

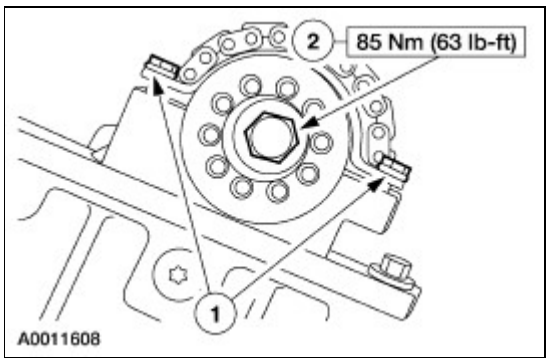
    Install the special tools on the rear of the LH cylinder head.



84. Install the special tool.

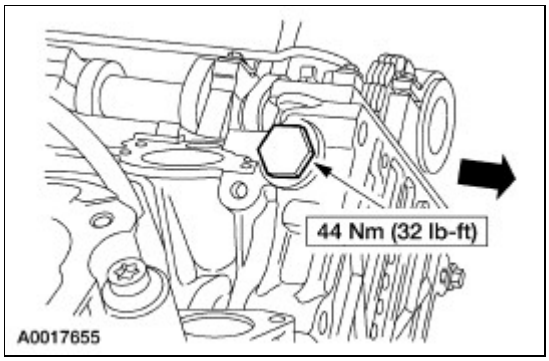


85. Tighten the bolts.
    1. Tighten the special tool top two clamp bolts to 10 Nm (89 lb-in).
    2. Tighten the camshaft bolt.



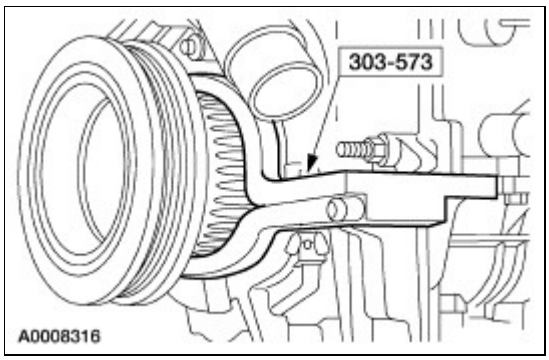
86. **NOTE:** When using a new washer the camshaft tensioner must be torqued to 44Nm (32lb-ft).

    Remove the special tool and install the LH camshaft tensioner.



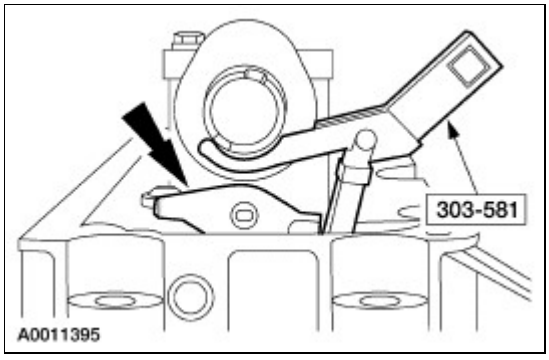
87. Remove the special tools from the LH cylinder head.

88. Remove the special tool.

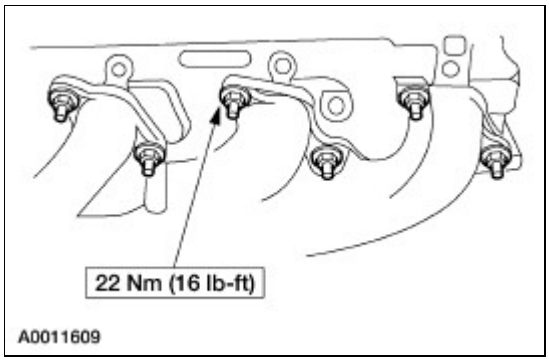


89. **NOTE:** Lubricate the parts with clean engine oil prior to installing.

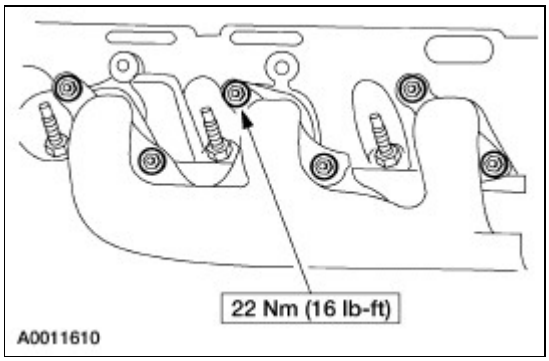
    Using the special tool, install the roller followers in their original position.



90. Install the gasket and the LH exhaust manifold.

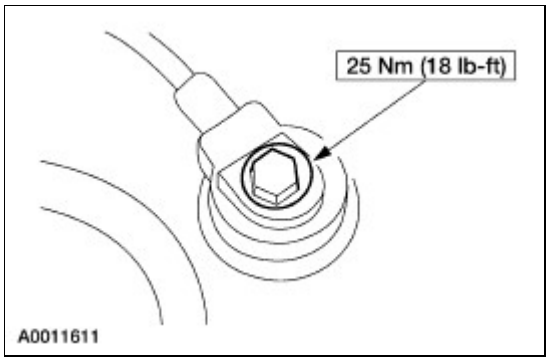


91. Install the gasket and the RH exhaust manifold.

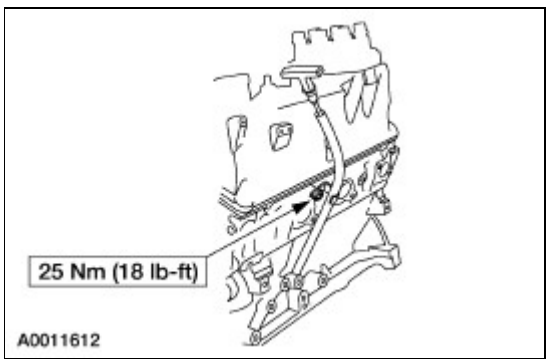


92. **NOTE:** Prior to installation, use metal surface cleaner to clean the mating surfaces.

    Install the knock sensor.

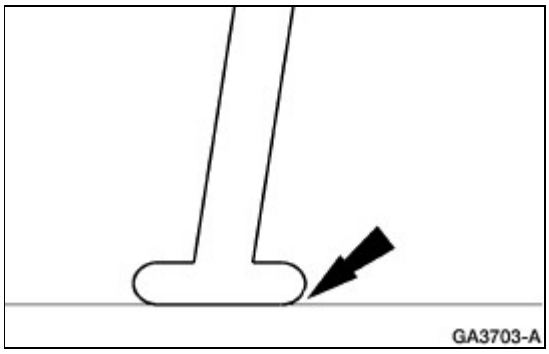


93. Install the oil level indicator tube.

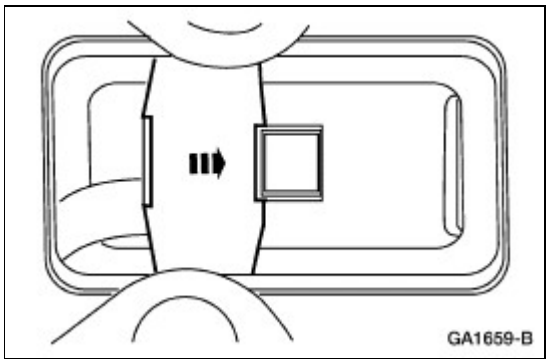


94. **NOTE:** If the oil level indicator tube is not installed flush with the cylinder block, false readings of the oil level may occur.

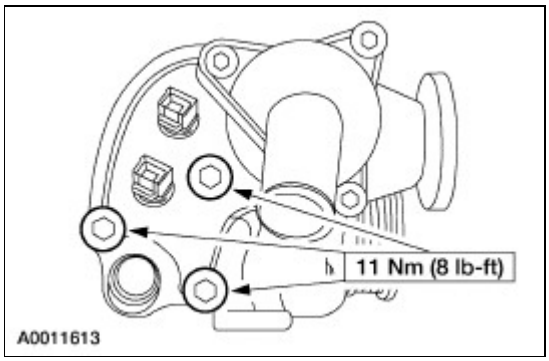
    Make sure the oil level indicator tube is flush with the cylinder block.



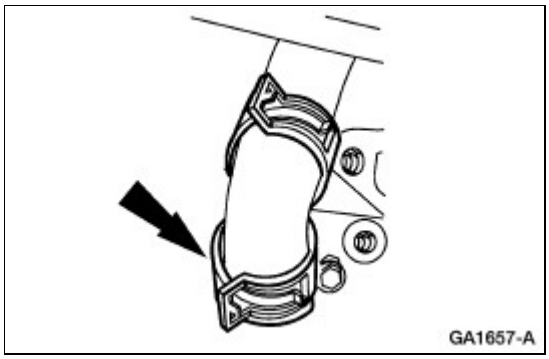
95. Install the crankcase vent separator.



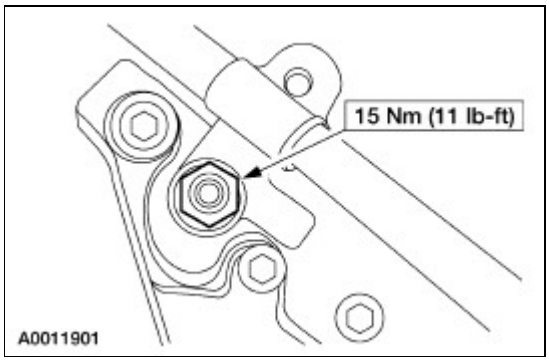
96. Install the thermostat housing.
    - Inspect and install a new gasket if necessary.



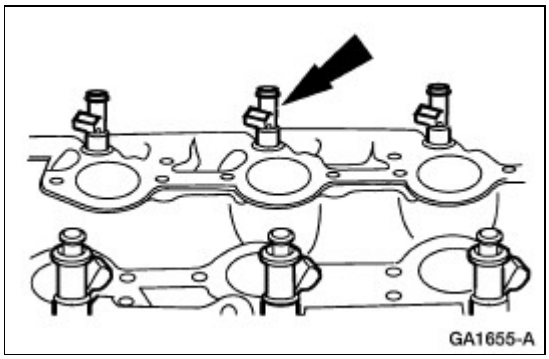
97. Connect the water bypass hose.



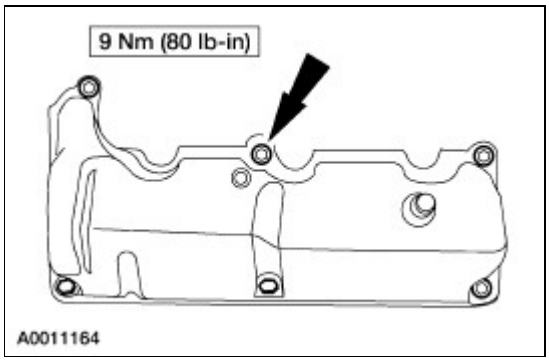
98. Install the vapor management valve (VMV) hose bracket.



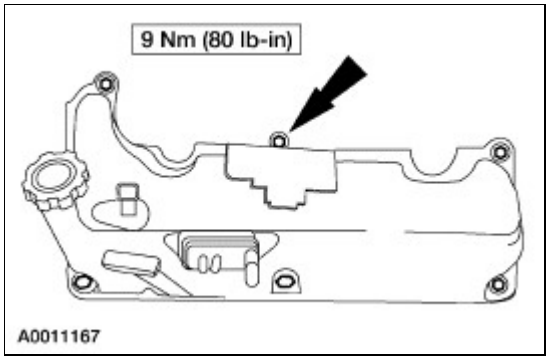
99. Install the fuel injectors.
    - Lubricate the fuel injector O-ring seals with clean engine oil.



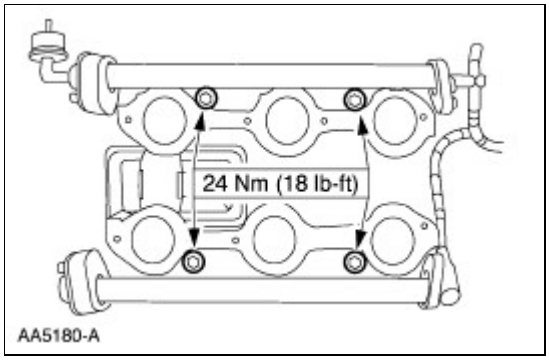
100. Install the gasket and the RH valve cover.



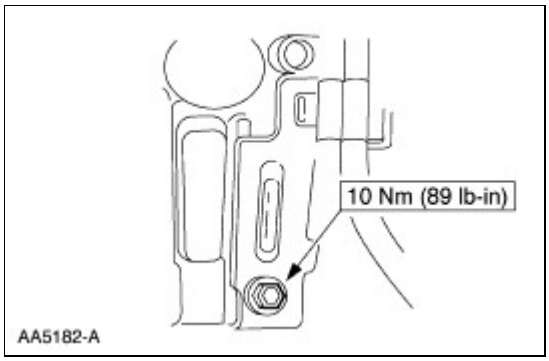
101. Install the gasket and the LH valve cover.



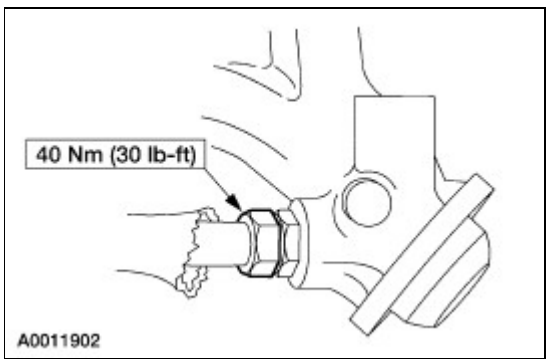
102. Install the fuel injection supply manifold.



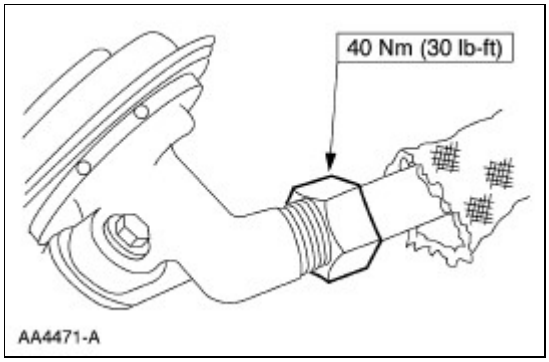
103. Install the lower fuel line bracket.



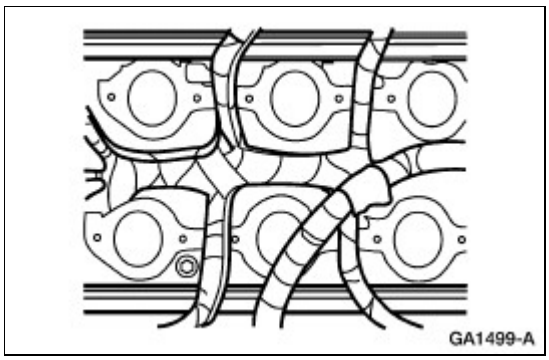
104. Connect the EGR valve to exhaust manifold tube to the exhaust manifold.



105. Connect the EGR valve to exhaust manifold tube to the EGR valve.

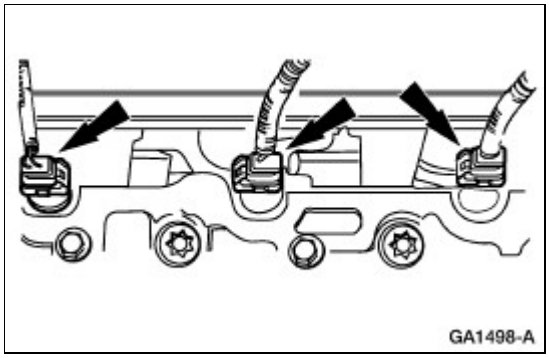


106. Install the fuel charging wiring.

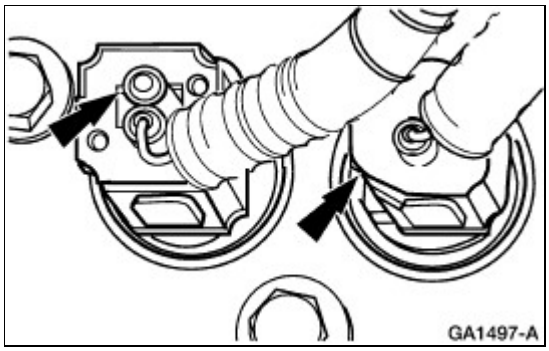


107. **NOTE:** LH shown, RH similar.

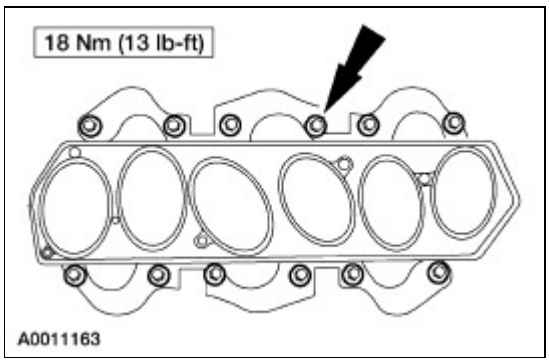
Connect the six fuel injector electrical connectors.



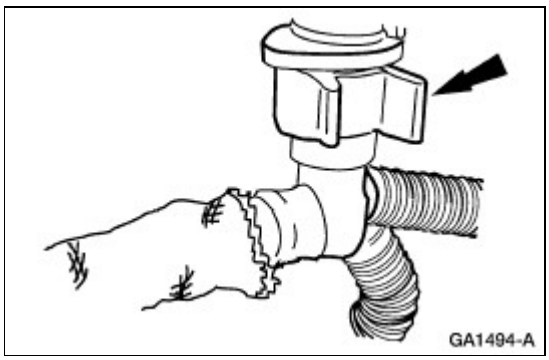
108. Connect the water temperature indicator sender unit and the engine coolant temperature (ECT) sensor electrical connectors.



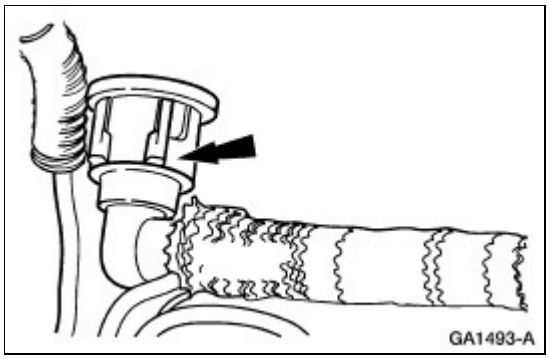
109. Install the lower intake manifold.



110. Connect the LH VMV hose.

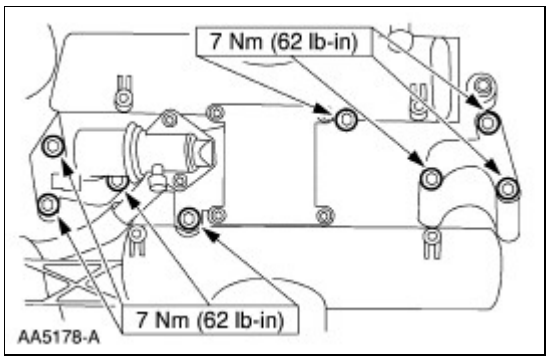


111. Connect the RH VMV hose.

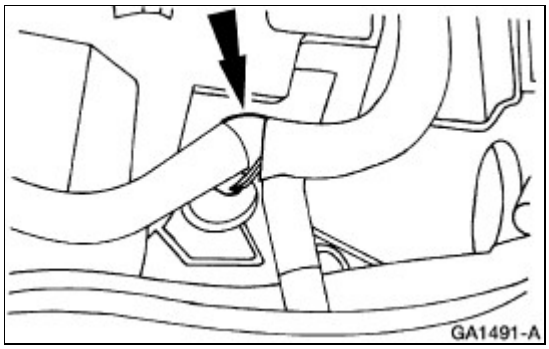


112. Install the upper intake manifold.

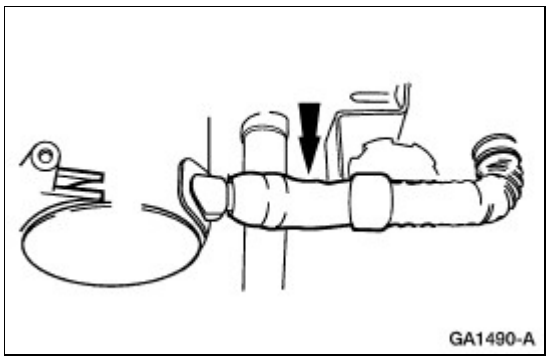
- Inspect and install a new gasket if necessary.



113. Connect the crankcase ventilation hose.



114. Connect the RH upper intake manifold vacuum hose.

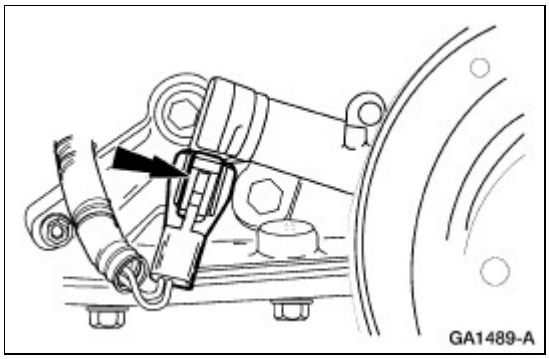


115. **CAUTION: Make sure to orient the spark plug boots so the spark plug wires do not contact the exhaust manifolds. Wire contact can send voltage spikes to other electronic modules.**

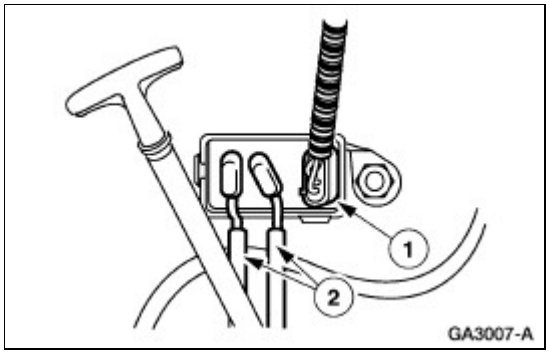
NOTE: Apply silicone brake caliper and dielectric compound to the inside of the spark plug boots.

Connect the spark plug wires to the spark plugs.

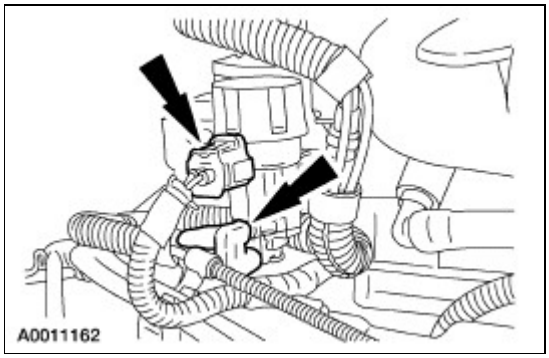
116. Connect the crankshaft position (CKP) sensor electrical connector.



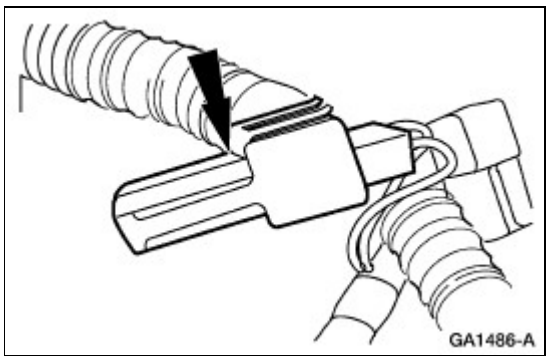
117. Connect the differential pressure feedback EGR transducer.
    1. Connect electrical connector.
    2. Connect vacuum hoses.



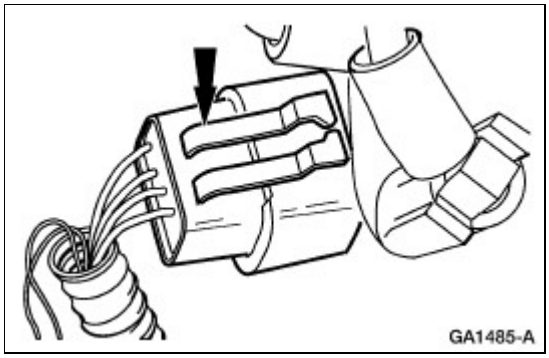
118. Connect the exhaust gas recirculation (EGR) vacuum regulator.



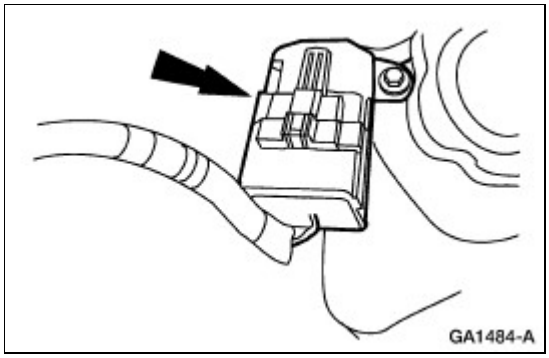
119. Connect the radio ignition interference capacitor electrical connector.



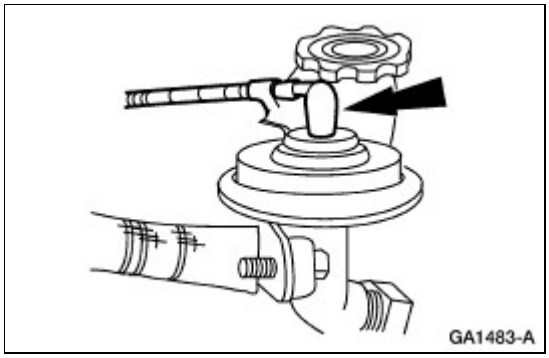
120. Connect the ignition coil electrical connector.



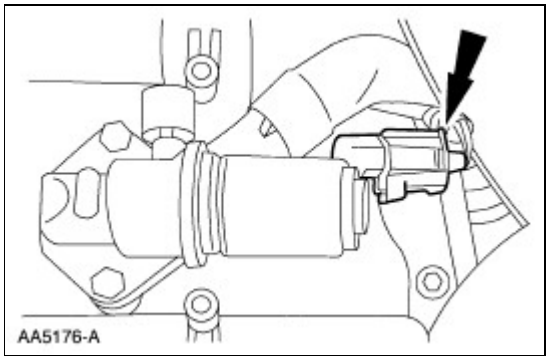
121. Connect the camshaft position (CMP) sensor electrical connector.



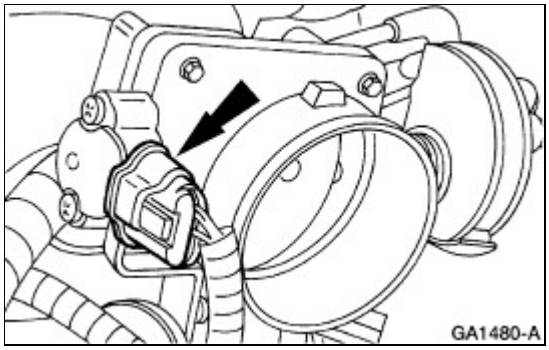
122. Connect the EGR valve vacuum hose.



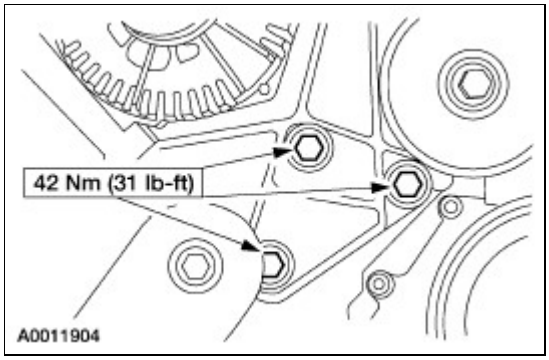
123. Connect the idle air control (IAC) valve electrical connector.



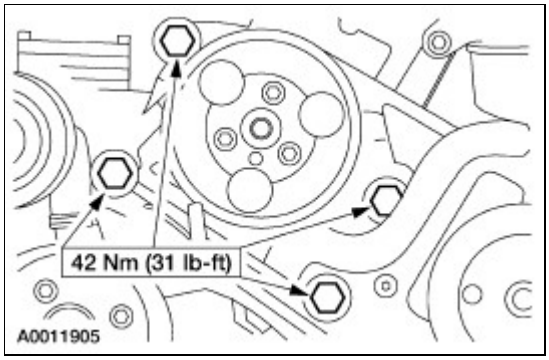
124. Connect the throttle position (TP) sensor electrical connector.



125. Install the generator mounting bracket.



126. Install the accessory bracket and tighten the bolts.



127. Rotate the drive belt tensioner counterclockwise and install the drive belt.
